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(sb or antimony)) or ni or nickel) 512927 L8L7 L6 and 15 120 L7L6 (phase near5 chang\$6) same 13 6816 L6L5 L4 same 13 1022 L5L4 ((mask\$3 or superresolution or (super near2 resolution)) near5 (film\$1  
or layer\$1)) 141794 L4L3 ((optical or laser or information) near5 (medium or media or disk\$1 or  
disc\$1)) 349861 L3L2 ((mask\$3 or superresolution) near5 (film\$1 or layer\$1)) 141584 L2*DB=USPT,JPAB,EPAB,DWPI,TDBD; PLUR=YES; OP=OR*L1 ((mask\$3 or superresolution) near5 (film\$1 or layer\$1)) 126881 L1

END OF SEARCH HISTORY

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention relates to the record method and recording device which used the member for record which uses energy beams, such as a laser beam, as a beam for record, and this member for record, and relates to the record method and recording device which used the suitable member for record to make record film into a multilayer and record a multiple value on the same place especially, and this member for record.

[0002]

[Description of the Prior Art] As everyone knows, as a beam for record, various proposals are made by energy beams, such as a laser beam and a charged-particle line, and the record method of the information which can record digital information which carried out FM modulation of the analog signals, such as an image and voice, such as a thing, data of a computer, a facsimile signal, and a digital audio signal, on real time, and the member for record are put in practical use. Hereafter, the case of the optical disk which performs information record using a laser beam is explained as an example of representation.

[0003] Information also turns variously in recent years and the demand of the optical disk with which a user can rewrite record or information for information has increased. Moreover, amount of information also increased and the mass optical disk has been needed.

[0004] Like the publication [ coping with this densification ] to JP,62-250529,A as one method Although it is high, the record film with which the record film of the monolayer containing some kinds of matter with which the melting points differ is used, or the melting points differ from the low thing of the incidence side of a laser beam to the melting point in order The energy level at the time of record is gradually changed from a crystalline-substance state to an amorphous state by multilayering through protective coats, such as SiO<sub>2</sub> film, by making it correspond to the melting point of the matter which constitutes record film, and choosing, and the attempt which performs multiple-value record in the same place is performed.

[0005]

[Problem(s) to be Solved by the Invention] in the above-mentioned Prior art, when the monolayer record film containing some kinds of matter with which the melting points differ is used, while repeating many rewritings, recombination of combination of the matter comrade from whom the melting point differs causes a segregation, and the melting point of each matter changes -- the recording characteristic changed by things and there was a problem of reducing reliability remarkably

[0006] Moreover, although the problem which says that the melting point of each matter changes is solved even if it repeats a change of state by rewriting operation, since the laminating of each record film is carried out through the protective coat when the record film with which the melting points differ is multilayered, it is very difficult to arrange record / elimination property of each record film that the melting points differ. It was difficult to arrange the configuration of such a property non-uniform mark (pit) sake [ a mark ] for example, recorded, and a size for every record film, and it was difficult to demonstrate the merit of multiple-value record to utilization level.

[0007] Since the material which constitutes each record film in order to form the multilayer from which this kind of melting point differs further again differs, membrane formation equipment is also complicated. For example, the membrane formation rooms (spatter membrane formation room etc.) near the several minutes laminating of record film are needed.

[0008] The purpose of this invention is to cancel the trouble of the above-mentioned conventional technology. therefore, the 1st purpose The improved member for record which multilayered the record film which enables reliable multiple-value record even if it rewrites repeatedly the 2nd purpose The new record method which used this member for record, and 3rd purposes are to offer the new recording device for realizing this record method, respectively.

[0009] It is in offering the record method and recording device using the member for record reliable [ still more specifically, it is cheap and high-speed record and reproduction are possible, and ], even if it repeats much records and rewritings the number of times and suitable making especially record film into a multilayer and carrying out multiple-value record in the same place, and it, respectively.

[0010]

[Means for Solving the Problem] The 1st purpose of the above is attained by the member for record which consists of multilayers which carried out the laminating of the record film from which it is the member for record which performs multiple-value record to multilayer record film, and recrystallization time until it changes the aforementioned multilayer record film from an amorphous state to a crystalline-substance state during cooling after dissolution differs through the dielectric layer, and changes by irradiation of an energy beam based on the information which should be recorded.

[0011] Here, recrystallization time is a property peculiar to record film, after record film dissolves by irradiation of an energy beam, it is the thing of the time taken to change from an amorphous state to a crystalline-substance state in the cooling process (transition), and the record film from which recrystallization time differs is record film from which the crystallized state after cooling differs with the cooling rate after the dissolution at the time of record. Therefore, if it is cooled with various cooling rates after dissolving the multilayer record film with which the laminating of the record film with which recrystallization time differs, respectively was carried out by record, corresponding to the number of layers of record film, record and multiple-value record by rewriting can be performed.

[0012] Each record film to multilayer can be variously chosen from well-known record film, be [ what is necessary / just since recrystallization time differs as the quality of the material ]. Although composition may differ because composition elements differ mutually, as for the upper shell of a membrane formation process, it is desirable to constitute from record film with which atomic composition ratios differ by the same element system, and a cheap record member is obtained from an atomic ratio being easily controllable by the spatter forming-membranes method, the CVD forming-membranes method, the vacuum deposition method, etc.

[0013] When it considers as such record film, for example, germanium-Sb-Te system record film is used altogether, recrystallization time can be easily changed by changing the content of Sb for every record film. Control of the content of Sb can form each record film within the same sputtering system from it being easy only by changing spatter conditions. Thus, it is more desirable for the element which constitutes record film to be substantially the same, and only for composition ratios to differ (you may differ about the element not more than content 10at%).

[0014] Moreover, since light may not arrive even to the record film by the side of the back of beam travelling direction when the light transmittance of the record film near the incidence side of an energy beam is low, it is necessary to make high the light transmittance of the record film near an incidence side. The light transmittance of the record film by the side of the back may be low. The thing of the composition which can be expressed with GeTe record film as record film which realizes this by  $1(\text{GeTe})-x(\text{GeSe})x$ : ( $0 \leq x \leq 0.4$ ) which added GeSe, for example, And there are a thing from which the content of at least 2 elements of this composition changed less than \*\*10%, a thing by which all atomic numbers joined [ other elements ] the above-mentioned composition 10% or less (the direction of a light transmittance with many amounts of Se is high).

[0015] Moreover, if the melting point of each record film is mutually near, since a setup of the power level at the time of record is easy and the whole multilayer record film can be dissolved with necessary minimum fixed power level, it is desirable. The same effect is acquired when changing film composition of Ag-In-Sb-Te system record film.

[0016] Optically, on a transparent substrate, through direct or a protective layer, such multilayer record film carries out the laminating of record film and the dielectric layer by turns, and is formed. A protective coat consists of at least 1 person among an inorganic substance and the organic substance, and can consist of same objects as the above-mentioned dielectric layer.

[0017] The dielectric layer made to intervene between record film has little influence of the composition change by melting combination of record film, film deformation, the record sensitivity fall by the rise of the optimal record power, etc., even if it is isolated in between each record film and repeats rewriting frequently, and since it can maintain the always stabilized recording characteristic, it is desirable. As this kind of a dielectric layer, a SiO<sub>2</sub> independent layer, the mixolimnion of ZnS and SiO<sub>2</sub>, etc. are mentioned, for example.

[0018] Moreover, although it is usually about 10-200nm from the ability of the influence of a record sensitivity fall etc. not to be disregarded when too thick [ about the thickness of a dielectric layer, if too thin, the effect over the composition change and film deformation of record film by melting combination is inadequate, and ], it is 20-100nm preferably practical. The thickness of each dielectric layer at the time of inserting between record film and multilayering may not be the same.

[0019] Moreover, if the thin metal layer of the translucency like for example, an Au-Ag system alloy layer is further prepared as a control film of the reflected light between energy beam incidence sides, i.e., a substrate and the first record film, in case recording information will be read, a total reflection factor can be made high, the large stability and the large signal level of tracking can be taken, and it is more desirable than the record film near the incidence side of an energy beam.

[0020] Moreover, it is more desirable to consider as the phase contrast type record film from which a reflection factor hardly changes even if it records the record film near the incidence side of an energy beam at least, but the phase of a reflection factor changes. Since the reflection factor and permeability at the time of record do not change by carrying out like this, record can be ensured.

[0021] Moreover, as for the alkali-metal element contained as an impurity in record film, it is desirable that it is less than [ 1at% ]. Thereby, it cannot happen easily that a record mark crystallizes and disappears. This is important for a phase-change optical disk not only the multilayer and the optical disk for multiple-value record of this invention but common.

[0022] Furthermore, it is desirable for Ar content contained in a protective layer or a reflecting layer to be less than [ 5at% ]. Thereby, it stops being able to happen easily that a void (air bubbles) occurs in record film by record rewriting many times. This is important also for a phase-change optical disk not only the multilayer and the optical disk for multiple-value record of this invention (the typical member for record of this invention is an optical disk) but common. Since Ar is incorporated during membrane formation from the atmosphere of the membrane formation process by sputtering, it should just control Ar content by the method of adjusting Ar capacity supplied, for example into plasma production atmosphere.

[0023] The 2nd purpose of the above is the record method of irradiating the energy beam based on the information which should be recorded at the above-mentioned multilayer record film using the above-mentioned member for record, and performing multiple-value record. While setting the power level of the record wave by the energy beam as the predetermined level which may dissolve any record film By making the cooling rate after dissolution correspond to a record sign, and choosing it, it is

attained by the record method which makes recording information the change of state of the record film after cooling with the combination of the peculiar recrystallization time of each record film, and the cooldown delay based on the selected cooling rate.

[0024] And the record wave corresponding to at least one record sign can change the reflection factor in the same place in multi-stage story in the record wave used for record or rewriting by using the record wave brought down to low power level rather than elimination power level (it brings down and is henceforth called a pulse) immediately after a record pulse, and multiple-value record can be performed.

[0025] A record wave in this case, the power level when bringing down to low power level rather than elimination power level immediately after a record pulse at least When it is made to change for every record pulse or brings down to low power level rather than elimination power level immediately after a record pulse corresponding to the information signal which should be recorded Time (henceforth, it brings down and is called width of face) to maintain to the low power level corresponding to the information signal which should be recorded is changed for every record pulse, and multiple-value record is ensured.

[0026] Moreover, a reflection factor more total than the combination of the recrystallization time after dissolution of each record film and the cooldown delay corresponding to the record pulse at the time of record can be changed by making recrystallization time after the dissolution at the time of record of the record film of at least one layer in the record film of the Records Department material to be used shorter than time (it is henceforth called a cooldown delay) until it falls from the melting point at the time of record to crystallization temperature.

[0027] For example, what is necessary is for the recrystallization time after dissolution to carry out the laminating of the long record film on both sides of a dielectric layer one by one from the incidence side of an energy beam like a laser beam, and just to change the number of the layers which the record film from the incidence side of an energy beam crystallizes to this member for record the record pulse width of a record pulse, or by bringing down, changing one of the width of face, or both, and changing a cooldown delay.

[0028] If record power level is fixed, it brings down with record wave-copy pulse width and the sum of width of face is fixed at this time, although record on positive each class can be performed by the easy record wave and it is desirable, even if it fixes record pulse width, it brings it down and it changes width of face etc., there is same effect.

[0029] Moreover, you may maintain at power level higher than the elimination power level after bringing down in order to make it kept long to the temperature which is easy to recrystallize, without bringing down especially, and the temperature of record film falling too much when width of face is narrow, maintaining at power level once higher than elimination power level fixed time after a pulse, or bringing down and maintaining at elimination power level fixed time after a pulse fixed time. Moreover, it is satisfactory, if only a reflection factor difference arises, even if the record mark after recrystallizing does not need to be in a perfect crystalline-substance state, for example, the center section of the record mark is an amorphous state.

[0030] In order to record new information certainly as the record method used by this invention by both of the methods, a continuation servo system and a sample servo system, without possible being influenced of the existing information but, the sample serve method which irradiates laser in the same place is more desirable.

[0031] Moreover, the member for record which multilayered the record film from which the state after cooling differs with the cooling rate of the above [ the 3rd purpose of the above ], The means to which this member for record is rotated or moved, a laser light source, and a means to condense the laser beam from a laser light source on the member for record, A storage means by which the translation table of a signal modulation means to change into a modulation code the signal which should be recorded, and the record sign corresponding to two or more record waves from which the power change just behind the modulation code which entered, and a record pulse differs is memorized beforehand, A record wave generation means to generate the record wave corresponding to the record sign according to the output of the storage means, The laser driving means which drive a laser light source by the record wave, and a means to change into an electrical signal the laser beam reflected from the member for record, It is realizable with the recording device which has a multiple-value-ized means to operate an electrical signal orthopedically to a multiple-value wave, the multiple-value-binary conversion means which carries out binary conversion of waveform of the multiple-value wave, and the means which a binary signal is decoded and is made into an informational signal.

[0032] Furthermore, at least one record wave shall be lowered to low power level rather than elimination power level immediately after a record pulse as the above-mentioned record wave generation means. When a reflection factor changes in multi-stage story in the same place, the above-mentioned multiple-value-ized means changes into a stair-like multiple-value wave the reproduction electrical signal with which intensity is changed, and has further an above-mentioned multiple-value-binary conversion means to change a multiple-value wave into a binary wave, at least.

[0033] Time to maintain it to the low power level corresponding to the information signal which should be recorded at this time, when power level when a record wave generation means lowers to low power level rather than elimination power level immediately after a record pulse at least if needed is changed corresponding to the information signal which should be recorded and is lowered to low power level rather than elimination power level immediately after a record pulse at least is changed.

[0034] By using substrate thickness of a disk as a 0.3-0.5mm super-thin shape disk, since the part to which equipment and a disk will carry and it will become easy if the diameter of a disk is made into 3.5 inches or less, and area becomes small, and storage capacity falls can enlarge numerical aperture (NA) of a condenser lens, it can make a record unit area small and can record mass information. It is important for a phase-change optical disk not only the multilayer and the optical disk for multiple-value record of this invention but common to consider as such small and a super-thin shape disk.

[0035]

[Function] The member for record which multilayered the record film with which the recrystallization time of this invention differs differs from what multilayered the record film with which the conventional melting points differ theoretically. That is, since each class can form the record mark of the same configuration mostly between adjoining record film by considering as the multilayering structure of the record film which gave the difference of recrystallization time, read-out of information becomes easy.

[0036] That is, in this invention, at the time of record or rewriting, it is made to correspond to the information signal which should be recorded as the cooling rate after a temperature up becomes varieties, and a record wave is chosen arbitrarily. Moreover, a multiple value is recorded on the same place by changing the recrystallization time after dissolution of the record film to be used for every layer, for example, forming record film from the incidence side of a laser beam, so that recrystallization time may become long toward a back side.

[0037] If this records by record power from which the whole record film becomes the temperature beyond the melting point, as for the record film with the recrystallization time shorter than a subsequent cooldown delay after dissolution of record film, recrystallization will happen between them. Composition differs mutually [ record film ] at three layers. each recrystallization time from the record film near the incidence side of a laser beam for example, in 50ns, 100ns, and 200ns When the cooldown delay at the time of irradiating a record pulse is 150ns The portion dissolved by the record pulse of the record film from the incidence side of a laser beam to a two-layer eye will be recrystallized during cooling, and will be in a crystallized state (at this time, since the cooldown delay of the 3rd layer is shorter than recrystallization time, the portion of an amorphous state remains).

[0038] Here, a cooldown delay changes by changing a record wave. The record wave especially lowered to low power level rather than elimination power level immediately after a record pulse is used. The power level when lowering to low power level rather than elimination power level immediately after this record pulse An effect is large, when it is made to change corresponding to the information signal which should be recorded, or it lowers to low power level rather than elimination power level immediately after a record pulse and time to maintain to the low power level corresponding to the information signal which should be recorded is changed.

[0039] Thus, from the combination of the recrystallization time of the record film of each class, and the cooldown delay corresponding to the record pulse at the time of record, two or more sorts of reflection factors corresponding to the number of layers made amorphous can be obtained, and multiple-value record is realized.

[0040] In the member for record used by this invention, the influence of the composition change by melting mixture of the record film at the time of record, film deformation, a record sensitivity fall, etc. decreases by setting thickness of the dielectric layer between each record film and record film to 10-200nm (20-100nm being desirable especially).

[0041] Moreover, substantially, using the same composition element (you may differ about the element not more than content 10at%), if the record film used for each class changes recrystallization time by the difference in the composition ratio of each of that element, it can form each record film within the same sputtering system. For example, if two kinds of targets, the target of germanium<sub>2</sub>Sb<sub>2</sub>Te<sub>5</sub> composition and the target of Sb, are arranged to the same spatter interior of a room and the spatter power of Sb target is changed when a germanium-Sb-Te system with a good rewriting property is used, the amount of Sb(s) in each record film will be changed (the recrystallization time of record film becomes late, so that many amounts of Sb(s) are contained). Thus, when the element which constitutes multilayer record film is the same, the membrane formation process of each record film carries out in the same spatter interior of a room, and it is effective in the ability to simplify a process by \*\*'s.

[0042] Moreover, since a setup of a near thing, then the power level at the time of record is mutually easy in the melting point of each record film, the whole multilayer record film can be dissolved with necessary minimum fixed power level, a record wave can be made simple, and it is desirable (it is still more desirable if it is the same temperature).

[0043] Moreover, since light may not arrive even to the record film by the side of the back, the light transmittance of the record film near the incidence side of an energy beam makes high the light transmittance of the record film near an incidence side, and makes high gradually the absorption coefficient of the record film by the side of the back at a low case. As record film which realizes this, the germanium-Te-Se system record film which mixed GeTe and GeSe by the predetermined ratio is used, for example. By this system, since a light transmittance becomes high so that there are many amounts of Se, the record film by the side of the incidence of an energy beam should just make the ratio of GeSe high. Thereby, in the record film near an incidence side, it penetrates without absorbing light not much, and many light is absorbed with the record film by the side of the very back, and the record film of a near side makes it amorphous with the heat.

[0044] Moreover, since the reflection factor and permeability at the time of record do not change by using the record film near the incidence side of an energy beam at least as a phase contrast type, record can be ensured.

[0045] Moreover, an alkali-metal element may promote crystallization of record film. If an alkali-metal element exists during a record mark, while time will pass, a record mark crystallizes, information disappears and it becomes a problem. Therefore, as for the alkali-metal element contained in the record film to be used, it is desirable that it is less than [ 1at% ].

[0046] Furthermore, in order to prevent Ar atom contained in a protective layer oozing out in record film by many record rewritings, and forming a void, it is desirable for Ar content contained in a protective layer to be less than [ 5at% ]. It is still more desirable if Ar content contained in a reflecting layer by the same reason is also less than [ 5at% ].

[0047] The sample servo system which irradiates a laser beam as the record method used by this invention in the same place is more desirable. That is, although the jitter of a regenerative-signal wave may go up in response to the influence of the information before rewriting depending on the case in the continuation servo system which the irradiation field of a laser beam shifts at random whenever it rewrites, informational rewriting can be ensured in the sample servo system which performs laser beam irradiation in the same place.

[0048] Although this invention has mainly described the case where the record film which records information by change between crystal-amorphous is used, it is every layer of other record film from which the state after cooling differs with a cooling rate or phase-change record film, and these or is good also as a member for record using the combination within the same layer (disk).

[0049] There are thermochromic material, photochromic material, etc. as other record film from which the state after cooling differs with a cooling rate. A magneto-optic-recording film is also usable if it is easy to move a magnetic domain wall for composition or substrate surface flatness. Except phase-change record film, the dielectric layer between layers is also omissible. Moreover, this invention is applicable not only to the shape of a disk but the member for record of other gestalten, such as the shape of a card.

[0050]

[Example] Hereafter, one example of this invention is explained in detail according to a drawing.

<Example 1> Example drawing 1 of composition of the member for (1) record shows cross-section structural drawing of the optical disk used as the example of representation of the member for record. This example explains the case of the disk which made record film three layers. Hereafter, the composition of a disk is explained with a manufacturing process.

[0051] First, the Au-Ag system alloy layer 2 was formed by the magnetron-sputtering method at about 10nm in thickness on the polycarbonate substrate 1 for sample servoes with a diameter [ of 3.5 inches ], and a thickness of 0.6mm. This alloy layer 2 turns into a metal layer which controls the reflected light. Next, ZnS-SiO<sub>2</sub> dielectric layer with a thickness of about 125nm was formed as a protective coat 3.

[0052] Next, the record film 4 (it is henceforth called record film A) of germanium<sub>22</sub>Sb<sub>22</sub>Te<sub>56</sub> composition was formed by the spatter by using germanium<sub>2</sub>Sb<sub>2</sub>Te<sub>5</sub> as a target on ZnS-SiO<sub>2</sub> dielectric layer 3 at the thickness of about 15nm. Besides, ZnS-SiO<sub>2</sub> dielectric layer 5 was formed in about 30nm thickness. Furthermore, the record film 6 (it is henceforth called record film B) of germanium<sub>21</sub>Sb<sub>26</sub>Te<sub>53</sub> composition was formed by the simultaneous spatter of germanium<sub>2</sub>Sb<sub>2</sub>Te<sub>5</sub> target and Sb target on this at the thickness of about 15nm.

[0053] Furthermore, ZnS-SiO<sub>2</sub> dielectric layer 7 was formed on this at about 30nm thickness. And the record film 8 (it is henceforth called record film C) of germanium<sub>20</sub>Sb<sub>29</sub>Te<sub>51</sub> composition was formed by the simultaneous spatter of germanium<sub>2</sub>Sb<sub>2</sub>Te<sub>5</sub> target and Sb target on ZnS-SiO<sub>2</sub> dielectric layer 7 at the thickness of about 15nm.

[0054] Furthermore, after forming ZnS-SiO<sub>2</sub> dielectric layer 9 as a protective coat on this at about 100nm thickness, about 50nm of aluminum alloy reflecting layers 10 was formed. These membrane formation processes were performed one by one within the same sputtering system.

[0055] Then, after applying the ultraviolet-rays hardening resin layer 11 on this reflecting layer 10, hot melt adhesive 12 performed adhesion lamination of a substrate and the guard plate 13 made from a polycarbonate of this quality of the material. In addition, although this member for record explains the example of structure of one side record, it can also consider as double-sided record structure, and the member of two sheets obtained in the stage in front of it can be easily manufactured by making it rival with adhesives 12 so that membrane formation structure may become symmetrical mutually, without forming a guard plate 13 in that case.

[0056] Table 1 shows the recrystallization time after dissolution of the record film of each class.

[0057]

[Table 1]

表 1

記録膜の種類	再結晶化時間
記録膜A	6 0 ns
記録膜B	1 0 0 ns
記録膜C	1 5 0 ns

[0058] (2) It recorded by the pit position recording method by three kinds of record waves as shown in the example, thus the manufactured disk of the record method at drawing 2 (wave same also at the time of rewriting). That is, it becomes the pulse train which combined these three kinds of record waves according to the information signal which should be recorded. By using such two or more record waves, various states after cooling by the difference in a cooling rate are changeable.

[0059] Here, each record wave is once brought down from record power level to power level lower than elimination power level. The value of the brought-down power level is changed for three kinds of every record waves, and the cooldown delay at the time of record is controlled. Table 2 shows the cooldown delay of each record wave (I, II, III). Multiple-value record is attained with the combination of this cooldown delay and the recrystallization time of the record film of each class.

[0060]

[Table 2]

表 2

記録波形	冷却時間
I	5 0 ns
II	8 0 ns
III	1 2 0 ns

[0061]

[Table 3]

表 3

記録波形	記録膜A	記録膜B	記録膜C
I	●	●	●
II	○	●	●
III	○	○	●
(消去時)	○	○	○

○ 結晶化状態

● 非晶質化状態

[0062] That is, the cooldown delay at the time of recording by the record wave I, as shown in Table 3 is 50ns (refer to Table 2), since it is shorter than which recrystallization time of record film A, record film B, and record film C, it will quench it, and three layers of irradiation portions will be in an amorphous state (- mark). When recording by the record wave II (refer to [ 80ns of cooldown delays, and ] Table 2), record film A will recrystallize during cooling (O mark, crystallization state), and two-layer other ] will be in an amorphous state.

[0063] Furthermore, when recording by the record wave III (refer to [ 120ns of cooldown delays, and ] Table 2), record film A and record film B will be in a crystallized state, and record film C will be in an amorphous state. And after the state which is not recording once, or elimination which performed laser beam irradiation on elimination level, all three layers are in a crystallization state (refer to [ O mark and ] Table 3). With four kinds of this reflection factor, the information on double precision was able to be acquired compared with the case where the number of conventional record film is one.

[0064] In addition, it is as follows when the example of the record wave of Table 2 is shown. the power level of record by laser beam irradiation -- 14mW and elimination level -- 7mW and a regeneration level -- the width of face of 1mW and a record pulse -- and it brought down, and each width of face of a pulse is 45ns, it brought down and, in the case of the record wave I, in 1mW and II, the power level of a pulse was gradually changed with 5mW in 3mW and III Thereby, even if it performed 10,000 rewriting records about the same place, each record film was able to form the record mark of a simultaneously same configuration. Thus, what is necessary is just to constitute from record film shorter than a cooldown delay until the recrystallization time after the dissolution of record film of at least one layer of multilayer record film falls from the melting point at the time of record to crystallization temperature.

[0065] Drawing 3 shows the example of other record waves. Here, record power level and the example to which it brought down, and power level of a pulse was set constant, and was brought down, and the width of face of a pulse was changed are shown. Although record pulse width may be fixed and may be brought down, as shown in this drawing, and only pulse width may be changed at this time, it may bring down with record pulse width and the sum with pulse width may be fixed. The direction which fixed record pulse width is desirable at the point that record can be ensured.

[0066] Moreover, in order to bring down like the record wave III, and to ensure recrystallization further as the temperature of

record film does not fall too much, when pulse width is narrow, As it maintained at power level higher than elimination power level fixed time after bringing down and maintaining at elimination power level fixed time after a pulse, or shown in drawing 4 (a) What is necessary is to once maintain at power level higher than elimination power level fixed time after a pulse, or to bring down and just to maintain without a pulse at power level higher than elimination power level fixed time, as it brings down and was shown in drawing 4 (b). Power level higher than elimination power level here does not necessarily need to be the same as record power level.

[0067] Moreover, if the difference of the melting point is less than 40 degrees C like each record film used by this example, since a setup of the power level at the time of record is easy and the whole multilayer record film can be dissolved with necessary minimum fixed power level, it is desirable.

[0068] Thus, if it is record pulse width and the record wave which brings down, controls pulse width, each power level, etc. (the amount of energy), and can change a cooldown delay for every record pulse, the same effect will be acquired in other configurations.

[0069] It does not interfere, even if the record mark after recrystallization does not need to be a perfect crystallized state, for example, the center section of the record mark is in the state slightly near an amorphous state in this invention depending on the case.

[0070] (3) The various disks with which the thickness of the dielectric layer between each record film and record film differs about the thickness and the recording characteristic of a dielectric layer next were produced, and the noise change by the record sensitivity of each disk and rewriting was investigated. Consequently, noise elevation of 5dB or more was able to see the disk with the thickness of the dielectric layer between record film thinner than 10nm after 10,000 rewritings. When it was 20nm or more, there was almost no noise elevation.

[0071] Moreover, the record mark by which the thickness of the dielectric layer between each record film and record film is formed in a record layer far from an optical incidence side even if a disk 200nm or more enlarges record power with 20mW was small, and the modulation factor  $[=(\text{reflection factor of reflection factor-amorphous state of crystallized state})/(\text{reflection factor of a crystallized state})]$  was small. By setting thickness of a dielectric layer to 100nm or less, the optimal record power was set to 15mW or less, and record sensitivity improved.

[0072] As mentioned above, the influence of the composition change by melting mixture of the record film comrade at the time of record, film deformation, the record sensitivity fall by the fall of the optimal record power, etc. is desirable few by setting thickness of the dielectric layer between record film to 10nm - 200nm. Especially the thickness of a dielectric layer has 20nm - desirable 100nm. When the thickness of each dielectric layer was within the limits of the above, it was checked that it may not be the same as mutual.

[0073] (4) Like [ composition / of record film ] this example, since the element which constitutes record film can form each record film within a sputtering system with more nearly same changing recrystallization time by making it the same substantially (you differing about the element not more than content 10at%), and changing the composition ratio of each element in record film at least, it is desirable.

[0074] Moreover, although crystallization time was changed by changing the content of Sb of germanium-Sb-Te system record film in this example, there is an usable thing also with phase-change record film other than germanium-Sb-Te system record film. Especially, if there are many record number of layers, since light may not reach a low case even to the record film by the side of the back, the permeability of the record film near the incidence side of an energy beam will make the light transmittance of each record film high, or will make high the light transmittance of the record film by the side of incidence. The light transmittance of the record film by the side of the back may be low.

[0075] As record film which realizes this, the record film of  $1(\text{GeTe})\text{-}X(\text{GeSe})$   $X: (0 \leq X \leq 0.4)$  had effective composition. Since the direction with many amounts of Se was high at this time, the light transmittance made each record layer the composition in which more than 20 atom % is included for Se, or the record film by the side of optical incidence made [ many ] Se content.

[0076] The above result, in order to change the recrystallization time of each class of record film, when a composition element was the same, only by the composition ratios of record film differing, since the same sputtering room was used, the membrane formation process became simple, and using the record film with which elements differ, only the number corresponding to the number of layers did not need to use a sputtering room, and was able to produce the member for record cheaply.

[0077] Moreover, since the reflection factor and permeability of a layer of each [ direction / which was used as the phase contrast type ] do not change with information signals and the record film near the incidence side of an energy beam at least can ensure record to two or more layers, it is desirable.

[0078] Moreover, that a record mark crystallizes and disappears stopped being able to happen easily by making the alkali-metal element contained in the record film to be used into less than [ 1at% ]. Furthermore, by making into less than [ 5at% ] Ar content contained in a protective layer or a reflecting layer, the record film oxidization by Ar etc. was suppressed and the reliable disk became possible.

[0079] <Example 2> Drawing 5 is the block block diagram having shown one example of the recording device of this invention, and specifically shows an example of the block diagram of the record reversion system in a record regenerative apparatus. Hereafter, according to this drawing, an equipment configuration and operation are explained one by one.

[0080] First, the HARASHIN number (information) which should be recorded is inputted into a modulator 14 at the time of record, and it changes it into the modulation code to be used. And it records by the record wave corresponding to the target record sign by the translation table 15 of this modulation code and the record sign corresponding to two or more record waves (I,



II, III) from which the power change just behind a record pulse as shown in Table 4 differs. Here, "0" of a record sign means laser beam irradiation of elimination power level.

[0081] That is, the record wave generation machine 16 generates the record wave corresponding to the record sign, and it is outputted by the translation table 15 as a record pulse signal of various power. And according to this record pulse signal, the laser actuator 17 modulates the drive current of semiconductor laser 18, and it passes along the optical head 19, and on the revolving disk 20, it condenses, a laser beam is irradiated and a record mark is formed.

[0082] At the time of reproduction, the laser beam reflected from the address of the purpose of a disk 20 is incorporated by the electric eye 21, and it is changed into an electrical signal. And this electrical signal is inputted into a waveform equalizer 23 through the regenerative-signal amplifier 22. After inputting the signal which came out of the waveform equalizer 23 into the plastic surgery machine 24 orthopedically operated to a multiple-value wave, it changes a multiple-value wave into a binary wave with the multiple-value-binary converter 25. A multiple-value-ized means here changes into a stair-like multiple-value wave the reproduction electrical signal with which intensity is changed, when a reflection factor changes in multi-stage in the same place. Finally, it becomes a data bit train (information) by the discriminator 26 and the decoder 27 about a binary signal.

[0083]

[Table 4]

表 4

変調符号	記録符号	記録波形
0 0	0	(消去レベル)
0 1	1	III
1 0	2	II
1 1	3	I

[0084] In addition, the member for record obtained as a disk 20 in the example 1 which carried out the three-layer laminating of the record film was used. Although rewriting operation was continuously repeated 10,000 times using this recording device in order to verify the performance of record reproduction, deformation is not seen by the configuration of the mark recorded on each record film, but it is recorded in the same configuration, and the faithful record reproducing characteristics of high reliance were measured.

[0085] In this example, although the example of a sample servo system was shown, the effect with the same said of a continuation servo system was acquired.

[0086] Since numerical aperture of a lens was enlarged although record area became small, since the size of a disk was small when the diameter of a disk was made into 3.5 inches or less for the miniaturization of a recording device and substrate thickness of a disk was made into the range of 0.3-0.5mm, the mass super-thin shape disk was obtained.

[0087]

[Effect of the Invention] As explained in full detail above, this invention was able to attain the desired end. That is, by the record method by combination with the record wave from which cooling conditions differ using the member for record which multilayered the record film with which the states after cooling differ with a cooling rate, since the reflection factor in the same place was obtained by the multi-stage story, multiple-value record was attained. and each record layer can form the record mark of the same configuration mostly -- it could fold, read-out of recording information became certain, and multiple-value record of high reliance became realizable

[0088] Moreover, the recording device of this invention certainly enables realization of the record method which used the above-mentioned member for record, and promotes utilization of reliable repeat rewriting further.

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[Translation done.]

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**DETAILED DESCRIPTION**

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[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention relates to the record method and recording device which used the member for record which uses energy beams, such as a laser beam, as a beam for record, and this member for record, and relates to the record method and recording device which used the suitable member for record to make record film into a multilayer and record a multiple value on the same place especially, and this member for record.

[0002]

[Description of the Prior Art] As everyone knows, as a beam for record, various proposals are made by energy beams, such as a laser beam and a charged-particle line, and the record method of the information which can record digital information which carried out FM modulation of the analog signals, such as an image and voice, such as a thing, data of a computer, a facsimile signal, and a digital audio signal, on real time, and the member for record are put in practical use. Hereafter, the case of the optical disk which performs information record using a laser beam is explained as an example of representation.

[0003] Information also turns variously in recent years and the demand of the optical disk with which a user can rewrite record or information for information has increased. Moreover, amount of information also increased and the mass optical disk has been needed.

[0004] Like the publication [ coping with this densification ] to JP,62-250529,A as one method Although it is high, the record film with which the record film of the monolayer containing some kinds of matter with which the melting points differ is used, or the melting points differ from the low thing of the incidence side of a laser beam to the melting point in order The energy level at the time of record is gradually changed from a crystalline-substance state to an amorphous state by multilayering through protective coats, such as SiO<sub>2</sub> film, by making it correspond to the melting point of the matter which constitutes record film, and choosing, and the attempt which performs multiple-value record in the same place is performed.

[0005]

[Problem(s) to be Solved by the Invention] in the above-mentioned Prior art, when the monolayer record film containing some kinds of matter with which the melting points differ is used, while repeating many rewritings, recombination of combination of the matter comrade from whom the melting point differs causes a segregation, and the melting point of each matter changes -- the recording characteristic changed by things and there was a problem of reducing reliability remarkably

[0006] Moreover, although the problem which says that the melting point of each matter changes is solved even if it repeats a change of state by rewriting operation, since the laminating of each record film is carried out through the protective coat when the record film with which the melting points differ is multilayered, it is very difficult to arrange record / elimination property of each record film that the melting points differ. It was difficult to arrange the configuration of such a property non-uniform mark (pit) sake [ a mark ] for example, recorded, and a size for every record film, and it was difficult to demonstrate the merit of multiple-value record to utilization level.

[0007] Since the material which constitutes each record film in order to form the multilayer from which this kind of melting point differs further again differs, membrane formation equipment is also complicated. For example, the membrane formation rooms (spatter membrane formation room etc.) near the several minutes laminating of record film are needed.

[0008] The purpose of this invention is to cancel the trouble of the above-mentioned conventional technology. therefore, the 1st purpose The improved member for record which multilayered the record film which enables reliable multiple-value record even if it rewrites repeatedly the 2nd purpose The new record method which used this member for record, and 3rd purposes are to offer the new recording device for realizing this record method, respectively.

[0009] It is in offering the record method and recording device using the member for record reliable [ still more specifically, it is cheap and high-speed record and reproduction are possible, and ], even if it repeats much records and rewritings the number of times and suitable making especially record film into a multilayer and carrying out multiple-value record in the same place, and it, respectively.

[0010]

[Means for Solving the Problem] The 1st purpose of the above is attained by the member for record which consists of multilayers which carried out the laminating of the record film from which it is the member for record which performs multiple-value record to multilayer record film, and recrystallization time until it changes the aforementioned multilayer record film from an amorphous state to a crystalline-substance state during cooling after dissolution differs through the dielectric layer, and changes by irradiation of an energy beam based on the information which should be recorded.

[0011] Here, recrystallization time is a property peculiar to record film, after record film dissolves by irradiation of an energy beam, it is the thing of the time taken to change from an amorphous state to a crystalline-substance state in the cooling process (transition), and the record film from which recrystallization time differs is record film from which the crystallized state after cooling differs with the cooling rate after the dissolution at the time of record. Therefore, if it is cooled with various cooling rates after dissolving the multilayer record film with which the laminating of the record film with which recrystallization time differs, respectively was carried out by record, corresponding to the number of layers of record film, record and multiple-value record by rewriting can be performed.

[0012] Each record film to multilayer can be variously chosen from well-known record film, be [ what is necessary / just since recrystallization time differs as the quality of the material ]. Although composition may differ because composition elements differ mutually, as for the upper shell of a membrane formation process, it is desirable to constitute from record film with which atomic composition ratios differ by the same element system, and a cheap record member is obtained from an atomic ratio being easily controllable by the spatter forming-membranes method, the CVD forming-membranes method, the vacuum deposition method, etc.

[0013] When it considers as such record film, for example, germanium-Sb-Te system record film is used altogether, recrystallization time can be easily changed by changing the content of Sb for every record film. Control of the content of Sb can form each record film within the same sputtering system from it being easy only by changing spatter conditions. Thus, it is more desirable for the element which constitutes record film to be substantially the same, and only for composition ratios to differ (you may differ about the element not more than content 10at%).

[0014] Moreover, since light may not arrive even to the record film by the side of the back of beam travelling direction when the light transmittance of the record film near the incidence side of an energy beam is low, it is necessary to make high the light transmittance of the record film near an incidence side. The light transmittance of the record film by the side of the back may be low. The thing of the composition which can be expressed with GeTe record film as record film which realizes this by  $1(\text{GeTe})-x(\text{GeSe})x$ : ( $0 \leq x \leq 0.4$ ) which added GeSe, for example, And there are a thing from which the content of at least 2 elements of this composition changed less than \*\*10%, a thing by which all atomic numbers joined [ other elements ] the above-mentioned composition 10% or less (the direction of a light transmittance with many amounts of Se is high).

[0015] Moreover, if the melting point of each record film is mutually near, since a setup of the power level at the time of record is easy and the whole multilayer record film can be dissolved with necessary minimum fixed power level, it is desirable. The same effect is acquired when changing film composition of Ag-In-Sb-Te system record film.

[0016] Optically, on a transparent substrate, through direct or a protective layer, such multilayer record film carries out the laminating of record film and the dielectric layer by turns, and is formed. A protective coat consists of at least 1 person among an inorganic substance and the organic substance, and can consist of same objects as the above-mentioned dielectric layer.

[0017] The dielectric layer made to intervene between record film has little influence of the composition change by melting combination of record film, film deformation, the record sensitivity fall by the rise of the optimal record power, etc., even if it is isolated in between each record film and repeats rewriting frequently, and since it can maintain the always stabilized recording characteristic, it is desirable. As this kind of a dielectric layer, a SiO<sub>2</sub> independent layer, the mixolimnion of ZnS and SiO<sub>2</sub>, etc. are mentioned, for example.

[0018] Moreover, although it is usually about 10-200nm from the ability of the influence of a record sensitivity fall etc. not to be disregarded when too thick [ about the thickness of a dielectric layer, if too thin, the effect over the composition change and film deformation of record film by melting combination is inadequate, and ], it is 20-100nm preferably practical. The thickness of each dielectric layer at the time of inserting between record film and multilayering may not be the same.

[0019] Moreover, if the thin metal layer of the translucency like for example, an Au-Ag system alloy layer is further prepared as a control film of the reflected light between energy beam incidence sides, i.e., a substrate and the first record film, in case recording information will be read, a total reflection factor can be made high, the large stability and the large signal level of tracking can be taken, and it is more desirable than the record film near the incidence side of an energy beam.

[0020] Moreover, it is more desirable to consider as the phase contrast type record film from which a reflection factor hardly changes even if it records the record film near the incidence side of an energy beam at least, but the phase of a reflection factor changes. Since the reflection factor and permeability at the time of record do not change by carrying out like this, record can be ensured.

[0021] Moreover, as for the alkali-metal element contained as an impurity in record film, it is desirable that it is less than [ 1at% ]. Thereby, it cannot happen easily that a record mark crystallizes and disappears. This is important for a phase-change optical disk not only the multilayer and the optical disk for multiple-value record of this invention but common.

[0022] Furthermore, it is desirable for Ar content contained in a protective layer or a reflecting layer to be less than [ 5at% ]. Thereby, it stops being able to happen easily that a void (air bubbles) occurs in record film by record rewriting many times. This is important also for a phase-change optical disk not only the multilayer and the optical disk for multiple-value record of this invention (the typical member for record of this invention is an optical disk) but common. Since Ar is incorporated during membrane formation from the atmosphere of the membrane formation process by sputtering, it should just control Ar content by the method of adjusting Ar capacity supplied, for example into plasma production atmosphere.

[0023] The 2nd purpose of the above is the record method of irradiating the energy beam based on the information which should be recorded at the above-mentioned multilayer record film using the above-mentioned member for record, and performing multiple-value record. While setting the power level of the record wave by the energy beam as the predetermined level which may dissolve any record film By making the cooling rate after dissolution correspond to a record sign, and choosing it, it is

attained by the record method which makes recording information the change of state of the record film after cooling with the combination of the peculiar recrystallization time of each record film, and the cooldown delay based on the selected cooling rate.

[0024] And the record wave corresponding to at least one record sign can change the reflection factor in the same place in multi-stage story in the record wave used for record or rewriting by using the record wave brought down to low power level rather than elimination power level (it brings down and is henceforth called a pulse) immediately after a record pulse, and multiple-value record can be performed.

[0025] A record wave in this case, the power level when bringing down to low power level rather than elimination power level immediately after a record pulse at least When it is made to change for every record pulse or brings down to low power level rather than elimination power level immediately after a record pulse corresponding to the information signal which should be recorded Time (henceforth, it brings down and is called width of face) to maintain to the low power level corresponding to the information signal which should be recorded is changed for every record pulse, and multiple-value record is ensured.

[0026] Moreover, a reflection factor more total than the combination of the recrystallization time after dissolution of each record film and the cooldown delay corresponding to the record pulse at the time of record can be changed by making recrystallization time after the dissolution at the time of record of the record film of at least one layer in the record film of the Records Department material to be used shorter than time (it is henceforth called a cooldown delay) until it falls from the melting point at the time of record to crystallization temperature.

[0027] For example, what is necessary is for the recrystallization time after dissolution to carry out the laminating of the long record film on both sides of a dielectric layer one by one from the incidence side of an energy beam like a laser beam, and just to change the number of the layers which the record film from the incidence side of an energy beam crystallizes to this member for record the record pulse width of a record pulse, or by bringing down, changing one of the width of face, or both, and changing a cooldown delay.

[0028] If record power level is fixed, it brings down with record wave-copy pulse width and the sum of width of face is fixed at this time, although record on positive each class can be performed by the easy record wave and it is desirable, even if it fixes record pulse width, it brings it down and it changes width of face etc., there is same effect.

[0029] Moreover, you may maintain at power level higher than the elimination power level after bringing down in order to make it kept long to the temperature which is easy to recrystallize, without bringing down especially, and the temperature of record film falling too much when width of face is narrow, maintaining at power level once higher than elimination power level fixed time after a pulse, or bringing down and maintaining at elimination power level fixed time after a pulse fixed time. Moreover, it is satisfactory, if only a reflection factor difference arises, even if the record mark after recrystallizing does not need to be in a perfect crystalline-substance state, for example, the center section of the record mark is an amorphous state.

[0030] In order to record new information certainly as the record method used by this invention by both of the methods, a continuation servo system and a sample servo system, without possible being influenced of the existing information but, the sample serve method which irradiates laser in the same place is more desirable.

[0031] Moreover, the member for record which multilayered the record film from which the state after cooling differs with the cooling rate of the above [ the 3rd purpose of the above ], The means to which this member for record is rotated or moved, a laser light source, and a means to condense the laser beam from a laser light source on the member for record, A storage means by which the translation table of a signal modulation means to change into a modulation code the signal which should be recorded, and the record sign corresponding to two or more record waves from which the power change just behind the modulation code which entered, and a record pulse differs is memorized beforehand, A record wave generation means to generate the record wave corresponding to the record sign according to the output of the storage means, The laser driving means which drive a laser light source by the record wave, and a means to change into an electrical signal the laser beam reflected from the member for record, It is realizable with the recording device which has a multiple-value-ized means to operate an electrical signal orthopedically to a multiple-value wave, the multiple-value-binary conversion means which carries out binary conversion of waveform of the multiple-value wave, and the means which a binary signal is decoded and is made into an informational signal.

[0032] Furthermore, at least one record wave shall be lowered to low power level rather than elimination power level immediately after a record pulse as the above-mentioned record wave generation means. When a reflection factor changes in multi-stage story in the same place, the above-mentioned multiple-value-ized means changes into a stair-like multiple-value wave the reproduction electrical signal with which intensity is changed, and has further an above-mentioned multiple-value-binary conversion means to change a multiple-value wave into a binary wave, at least.

[0033] Time to maintain it to the low power level corresponding to the information signal which should be recorded at this time, when power level when a record wave generation means lowers to low power level rather than elimination power level immediately after a record pulse at least if needed is changed corresponding to the information signal which should be recorded and is lowered to low power level rather than elimination power level immediately after a record pulse at least is changed.

[0034] By using substrate thickness of a disk as a 0.3-0.5mm super-thin shape disk, since the part to which equipment and a disk will carry and it will become easy if the diameter of a disk is made into 3.5 inches or less, and area becomes small, and storage capacity falls can enlarge numerical aperture (NA) of a condenser lens, it can make a record unit area small and can record mass information. It is important for a phase-change optical disk not only the multilayer and the optical disk for multiple-value record of this invention but common to consider as such small and a super-thin shape disk.

[0035]

[Function] The member for record which multilayered the record film with which the recrystallization time of this invention differs differs from what multilayered the record film with which the conventional melting points differ theoretically. That is, since each class can form the record mark of the same configuration mostly between adjoining record film by considering as the multilayering structure of the record film which gave the difference of recrystallization time, read-out of information becomes easy.

[0036] That is, in this invention, at the time of record or rewriting, it is made to correspond to the information signal which should be recorded as the cooling rate after a temperature up becomes varieties, and a record wave is chosen arbitrarily. Moreover, a multiple value is recorded on the same place by changing the recrystallization time after dissolution of the record film to be used for every layer, for example, forming record film from the incidence side of a laser beam, so that recrystallization time may become long toward a back side.

[0037] If this records by record power from which the whole record film becomes the temperature beyond the melting point, as for the record film with the recrystallization time shorter than a subsequent cooldown delay after dissolution of record film, recrystallization will happen between them. Composition differs mutually [ record film ] at three layers. each recrystallization time from the record film near the incidence side of a laser beam for example, in 50ns, 100ns, and 200ns When the cooldown delay at the time of irradiating a record pulse is 150ns The portion dissolved by the record pulse of the record film from the incidence side of a laser beam to a two-layer eye will be recrystallized during cooling, and will be in a crystallized state (at this time, since the cooldown delay of the 3rd layer is shorter than recrystallization time, the portion of an amorphous state remains).

[0038] Here, a cooldown delay changes by changing a record wave. The record wave especially lowered to low power level rather than elimination power level immediately after a record pulse is used. The power level when lowering to low power level rather than elimination power level immediately after this record pulse An effect is large, when it is made to change corresponding to the information signal which should be recorded, or it lowers to low power level rather than elimination power level immediately after a record pulse and time to maintain to the low power level corresponding to the information signal which should be recorded is changed.

[0039] Thus, from the combination of the recrystallization time of the record film of each class, and the cooldown delay corresponding to the record pulse at the time of record, two or more sorts of reflection factors corresponding to the number of layers made amorphous can be obtained, and multiple-value record is realized.

[0040] In the member for record used by this invention, the influence of the composition change by melting mixture of the record film at the time of record, film deformation, a record sensitivity fall, etc. decreases by setting thickness of the dielectric layer between each record film and record film to 10-200nm (20-100nm being desirable especially).

[0041] Moreover, substantially, using the same composition element (you may differ about the element not more than content 10at%), if the record film used for each class changes recrystallization time by the difference in the composition ratio of each of that element, it can form each record film within the same sputtering system. For example, if two kinds of targets, the target of germanium<sub>2</sub>Sb<sub>2</sub>Te<sub>5</sub> composition and the target of Sb, are arranged to the same spatter interior of a room and the spatter power of Sb target is changed when a germanium-Sb-Te system with a good rewriting property is used, the amount of Sb(s) in each record film will be changed (the recrystallization time of record film becomes late, so that many amounts of Sb(s) are contained). Thus, when the element which constitutes multilayer record film is the same, the membrane formation process of each record film carries out in the same spatter interior of a room, and it is effective in the ability to simplify a process by \*\*s.

[0042] Moreover, since a setup of a near thing, then the power level at the time of record is mutually easy in the melting point of each record film, the whole multilayer record film can be dissolved with necessary minimum fixed power level, a record wave can be made simple, and it is desirable (it is still more desirable if it is the same temperature).

[0043] Moreover, since light may not arrive even to the record film by the side of the back, the light transmittance of the record film near the incidence side of an energy beam makes high the light transmittance of the record film near an incidence side, and makes high gradually the absorption coefficient of the record film by the side of the back at a low case. As record film which realizes this, the germanium-Te-Se system record film which mixed GeTe and GeSe by the predetermined ratio is used, for example. By this system, since a light transmittance becomes high so that there are many amounts of Se, the record film by the side of the incidence of an energy beam should just make the ratio of GeSe high. Thereby, in the record film near an incidence side, it penetrates without absorbing light not much, and many light is absorbed with the record film by the side of the very back, and the record film of a near side makes it amorphous with the heat.

[0044] Moreover, since the reflection factor and permeability at the time of record do not change by using the record film near the incidence side of an energy beam at least as a phase contrast type, record can be ensured.

[0045] Moreover, an alkali-metal element may promote crystallization of record film. If an alkali-metal element exists during a record mark, while time will pass, a record mark crystallizes, information disappears and it becomes a problem. Therefore, as for the alkali-metal element contained in the record film to be used, it is desirable that it is less than [ 1at% ].

[0046] Furthermore, in order to prevent Ar atom contained in a protective layer oozing out in record film by many record rewritings, and forming a void, it is desirable for Ar content contained in a protective layer to be less than [ 5at% ]. It is still more desirable if Ar content contained in a reflecting layer by the same reason is also less than [ 5at% ].

[0047] The sample servo system which irradiates a laser beam as the record method used by this invention in the same place is more desirable. That is, although the jitter of a regenerative-signal wave may go up in response to the influence of the information before rewriting depending on the case in the continuation servo system which the irradiation field of a laser beam shifts at random whenever it rewrites, informational rewriting can be ensured in the sample servo system which performs laser beam irradiation in the same place.

[0048] Although this invention has mainly described the case where the record film which records information by change between crystal-amorphous is used, it is every layer of other record film from which the state after cooling differs with a cooling rate or phase-change record film, and these or is good also as a member for record using the combination within the same layer (disk).

[0049] There are thermochromic material, photochromic material, etc. as other record film from which the state after cooling differs with a cooling rate. A magneto-optic-recording film is also usable if it is easy to move a magnetic domain wall for composition or substrate surface flatness. Except phase-change record film, the dielectric layer between layers is also omissible. Moreover, this invention is applicable not only to the shape of a disk but the member for record of other gestalten, such as the shape of a card.

[0050]

[Example] Hereafter, one example of this invention is explained in detail according to a drawing.

<Example 1> Example drawing 1 of composition of the member for (1) record shows cross-section structural drawing of the optical disk used as the example of representation of the member for record. This example explains the case of the disk which made record film three layers. Hereafter, the composition of a disk is explained with a manufacturing process.

[0051] First, the Au-Ag system alloy layer 2 was formed by the magnetron-sputtering method at about 10nm in thickness on the polycarbonate substrate 1 for sample servoes with a diameter [ of 3.5 inches ], and a thickness of 0.6mm. This alloy layer 2 turns into a metal layer which controls the reflected light. Next, ZnS-SiO<sub>2</sub> dielectric layer with a thickness of about 125nm was formed as a protective coat 3.

[0052] Next, the record film 4 (it is henceforth called record film A) of germanium<sub>22</sub>Sb<sub>22</sub>Te<sub>56</sub> composition was formed by the spatter by using germanium<sub>2</sub>Sb<sub>2</sub>Te<sub>5</sub> as a target on ZnS-SiO<sub>2</sub> dielectric layer 3 at the thickness of about 15nm. Besides, ZnS-SiO<sub>2</sub> dielectric layer 5 was formed in about 30nm thickness. Furthermore, the record film 6 (it is henceforth called record film B) of germanium<sub>21</sub>Sb<sub>26</sub>Te<sub>53</sub> composition was formed by the simultaneous spatter of germanium<sub>2</sub>Sb<sub>2</sub>Te<sub>5</sub> target and Sb target on this at the thickness of about 15nm.

[0053] Furthermore, ZnS-SiO<sub>2</sub> dielectric layer 7 was formed on this at about 30nm thickness. And the record film 8 (it is henceforth called record film C) of germanium<sub>20</sub>Sb<sub>29</sub>Te<sub>51</sub> composition was formed by the simultaneous spatter of germanium<sub>2</sub>Sb<sub>2</sub>Te<sub>5</sub> target and Sb target on ZnS-SiO<sub>2</sub> dielectric layer 7 at the thickness of about 15nm.

[0054] Furthermore, after forming ZnS-SiO<sub>2</sub> dielectric layer 9 as a protective coat on this at about 100nm thickness, about 50nm of aluminum alloy reflecting layers 10 was formed. These membrane formation processes were performed one by one within the same sputtering system.

[0055] Then, after applying the ultraviolet-rays hardening resin layer 11 on this reflecting layer 10, hot melt adhesive 12 performed adhesion lamination of a substrate and the guard plate 13 made from a polycarbonate of this quality of the material. In addition, although this member for record explains the example of structure of one side record, it can also consider as double-sided record structure, and the member of two sheets obtained in the stage in front of it can be easily manufactured by making it rival with adhesives 12 so that membrane formation structure may become symmetrical mutually, without forming a guard plate 13 in that case.

[0056] Table 1 shows the recrystallization time after dissolution of the record film of each class.

[0057]

[Table 1]

表 1

記録膜の種類	再結晶化時間
記録膜A	6 0 ns
記録膜B	1 0 0 ns
記録膜C	1 5 0 ns

[0058] (2) It recorded by the pit position recording method by three kinds of record waves as shown in the example, thus the manufactured disk of the record method at drawing 2 (wave same also at the time of rewriting). That is, it becomes the pulse train which combined these three kinds of record waves according to the information signal which should be recorded. By using such two or more record waves, various states after cooling by the difference in a cooling rate are changeable.

[0059] Here, each record wave is once brought down from record power level to power level lower than elimination power level. The value of the brought-down power level is changed for three kinds of every record waves, and the cooldown delay at the time of record is controlled. Table 2 shows the cooldown delay of each record wave (I, II, III). Multiple-value record is attained with the combination of this cooldown delay and the recrystallization time of the record film of each class.

[0060]

[Table 2]

表 2

記録波形	冷却時間
I	5 0 ns
II	8 0 ns
III	1 2 0 ns

[0061]

[Table 3]

表 3

記録波形	記録膜A	記録膜B	記録膜C
I	●	●	●
II	○	●	●
III	○	○	●
(消去時)	○	○	○

○ 結晶化状態

● 非晶質化状態

[0062] That is, the cooldown delay at the time of recording by the record wave I, as shown in Table 3 is 50ns (refer to Table 2), since it is shorter than which recrystallization time of record film A, record film B, and record film C, it will quench it, and three layers of irradiation portions will be in an amorphous state (- mark). When recording by the record wave II (refer to [ 80ns of cooldown delays, and ] Table 2), record film A will recrystallize during cooling (O mark, crystallization state), and two-layer other ] will be in an amorphous state.

[0063] Furthermore, when recording by the record wave III (refer to [ 120ns of cooldown delays, and ] Table 2), record film A and record film B will be in a crystallized state, and record film C will be in an amorphous state. And after the state which is not recording once, or elimination which performed laser beam irradiation on elimination level, all three layers are in a crystallization state (refer to [ O mark and ] Table 3). With four kinds of this reflection factor, the information on double precision was able to be acquired compared with the case where the number of conventional record film is one.

[0064] In addition, it is as follows when the example of the record wave of Table 2 is shown. the power level of record by laser beam irradiation -- 14mW and elimination level -- 7mW and a regeneration level -- the width of face of 1mW and a record pulse -- and it brought down, and each width of face of a pulse is 45ns, it brought down and, in the case of the record wave I, in 1mW and II, the power level of a pulse was gradually changed with 5mW in 3mW and III Thereby, even if it performed 10,000 rewriting records about the same place, each record film was able to form the record mark of a simultaneously same configuration. Thus, what is necessary is just to constitute from record film shorter than a cooldown delay until the recrystallization time after the dissolution of record film of at least one layer of multilayer record film falls from the melting point at the time of record to crystallization temperature.

[0065] Drawing 3 shows the example of other record waves. Here, record power level and the example to which it brought down, and power level of a pulse was set constant, and was brought down, and the width of face of a pulse was changed are shown. Although record pulse width may be fixed and may be brought down, as shown in this drawing, and only pulse width may be changed at this time, it may bring down with record pulse width and the sum with pulse width may be fixed. The direction which fixed record pulse width is desirable at the point that record can be ensured.

[0066] Moreover, in order to bring down like the record wave III, and to ensure recrystallization further as the temperature of

record film does not fall too much, when pulse width is narrow, As it maintained at power level higher than elimination power level fixed time after bringing down and maintaining at elimination power level fixed time after a pulse, or shown in drawing 4 (a) What is necessary is to once maintain at power level higher than elimination power level fixed time after a pulse, or to bring down and just to maintain without a pulse at power level higher than elimination power level fixed time, as it brings down and was shown in drawing 4 (b). Power level higher than elimination power level here does not necessarily need to be the same as record power level.

[0067] Moreover, if the difference of the melting point is less than 40 degrees C like each record film used by this example, since a setup of the power level at the time of record is easy and the whole multilayer record film can be dissolved with necessary minimum fixed power level, it is desirable.

[0068] Thus, if it is record pulse width and the record wave which brings down, controls pulse width, each power level, etc. (the amount of energy), and can change a cooldown delay for every record pulse, the same effect will be acquired in other configurations.

[0069] It does not interfere, even if the record mark after recrystallization does not need to be a perfect crystallized state, for example, the center section of the record mark is in the state slightly near an amorphous state in this invention depending on the case.

[0070] (3) The various disks with which the thickness of the dielectric layer between each record film and record film differs about the thickness and the recording characteristic of a dielectric layer next were produced, and the noise change by the record sensitivity of each disk and rewriting was investigated. Consequently, noise elevation of 5dB or more was able to see the disk with the thickness of the dielectric layer between record film thinner than 10nm after 10,000 rewritings. When it was 20nm or more, there was almost no noise elevation.

[0071] Moreover, the record mark by which the thickness of the dielectric layer between each record film and record film is formed in a record layer far from an optical incidence side even if a disk 200nm or more enlarges record power with 20mW was small, and the modulation factor  $[(\text{reflection factor of reflection factor-amorphous state of crystallized state})/(\text{reflection factor of a crystallized state})]$  was small. By setting thickness of a dielectric layer to 100nm or less, the optimal record power was set to 15mW or less, and record sensitivity improved.

[0072] As mentioned above, the influence of the composition change by melting mixture of the record film comrade at the time of record, film deformation, the record sensitivity fall by the fall of the optimal record power, etc. is desirable few by setting thickness of the dielectric layer between record film to 10nm - 200nm. Especially the thickness of a dielectric layer has 20nm - desirable 100nm. When the thickness of each dielectric layer was within the limits of the above, it was checked that it may not be the same as mutual.

[0073] (4) Like [ composition / of record film ] this example, since the element which constitutes record film can form each record film within a sputtering system with more nearly same changing recrystallization time by making it the same substantially (you differing about the element not more than content 10at%), and changing the composition ratio of each element in record film at least, it is desirable.

[0074] Moreover, although crystallization time was changed by changing the content of Sb of germanium-Sb-Te system record film in this example, there is an usable thing also with phase-change record film other than germanium-Sb-Te system record film. Especially, if there are many record number of layers, since light may not reach a low case even to the record film by the side of the back, the permeability of the record film near the incidence side of an energy beam will make the light transmittance of each record film high, or will make high the light transmittance of the record film by the side of incidence. The light transmittance of the record film by the side of the back may be low.

[0075] As record film which realizes this, the record film of  $1(\text{GeTe})\text{-}X(\text{GeSe})$   $X: (0 \leq X \leq 0.4)$  had effective composition. Since the direction with many amounts of Se was high at this time, the light transmittance made each record layer the composition in which more than 20 atom % is included for Se, or the record film by the side of optical incidence made [ many ] Se content.

[0076] The above result, in order to change the recrystallization time of each class of record film, when a composition element was the same, only by the composition ratios of record film differing, since the same sputtering room was used, the membrane formation process became simple, and using the record film with which elements differ, only the number corresponding to the number of layers did not need to use a sputtering room, and was able to produce the member for record cheaply.

[0077] Moreover, since the reflection factor and permeability of a layer of each [ direction / which was used as the phase contrast type ] do not change with information signals and the record film near the incidence side of an energy beam at least can ensure record to two or more layers, it is desirable.

[0078] Moreover, that a record mark crystallizes and disappears stopped being able to happen easily by making the alkali-metal element contained in the record film to be used into less than [ 1at% ]. Furthermore, by making into less than [ 5at% ] Ar content contained in a protective layer or a reflecting layer, the record film oxidization by Ar etc. was suppressed and the reliable disk became possible.

[0079] <Example 2> Drawing 5 is the block block diagram having shown one example of the recording device of this invention, and specifically shows an example of the block diagram of the record reversion system in a record regenerative apparatus. Hereafter, according to this drawing, an equipment configuration and operation are explained one by one.

[0080] First, the HARASHIN number (information) which should be recorded is inputted into a modulator 14 at the time of record, and it changes it into the modulation code to be used. And it records by the record wave corresponding to the target record sign by the translation table 15 of this modulation code and the record sign corresponding to two or more record waves (I,



II, III) from which the power change just behind a record pulse as shown in Table 4 differs. Here, "0" of a record sign means laser beam irradiation of elimination power level.

[0081] That is, the record wave generation machine 16 generates the record wave corresponding to the record sign, and it is outputted by the translation table 15 as a record pulse signal of various power. And according to this record pulse signal, the laser actuator 17 modulates the drive current of semiconductor laser 18, and it passes along the optical head 19, and on the revolving disk 20, it condenses, a laser beam is irradiated and a record mark is formed.

[0082] At the time of reproduction, the laser beam reflected from the address of the purpose of a disk 20 is incorporated by the electric eye 21, and it is changed into an electrical signal. And this electrical signal is inputted into a waveform equalizer 23 through the regenerative-signal amplifier 22. After inputting the signal which came out of the waveform equalizer 23 into the plastic surgery machine 24 orthopedically operated to a multiple-value wave, it changes a multiple-value wave into a binary wave with the multiple-value-binary converter 25. A multiple-value-ized means here changes into a stair-like multiple-value wave the reproduction electrical signal with which intensity is changed, when a reflection factor changes in multi-stage in the same place. Finally, it becomes a data bit train (information) by the discriminator 26 and the decoder 27 about a binary signal.

[0083]

[Table 4]

表 4

変調符号	記録符号	記録波形
0 0	0	(消去レベル)
0 1	1	III
1 0	2	II
1 1	3	I

[0084] In addition, the member for record obtained as a disk 20 in the example 1 which carried out the three-layer laminating of the record film was used. Although rewriting operation was continuously repeated 10,000 times using this recording device in order to verify the performance of record reproduction, deformation is not seen by the configuration of the mark recorded on each record film, but it is recorded in the same configuration, and the faithful record reproducing characteristics of high reliance were measured.

[0085] In this example, although the example of a sample servo system was shown, the effect with the same said of a continuation servo system was acquired.

[0086] Since numerical aperture of a lens was enlarged although record area became small, since the size of a disk was small when the diameter of a disk was made into 3.5 inches or less for the miniaturization of a recording device and substrate thickness of a disk was made into the range of 0.3-0.5mm, the mass super-thin shape disk was obtained.

[0087]

[Effect of the Invention] As explained in full detail above, this invention was able to attain the desired end. That is, by the record method by combination with the record wave from which cooling conditions differ using the member for record which multilayered the record film with which the states after cooling differ with a cooling rate, since the reflection factor in the same place was obtained by the multi-stage story, multiple-value record was attained. and each record layer can form the record mark of the same configuration mostly -- it could fold, read-out of recording information became certain, and multiple-value record of high reliance became realizable

[0088] Moreover, the recording device of this invention certainly enables realization of the record method which used the above-mentioned member for record, and promotes utilization of reliable repeat rewriting further.

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[Translation done.]